

# Statewide Cumulative Risk Screening



**Minnesota Pollution Control Agency**

**Chicago, IL**

**July / 2003**



# Statewide Cumulative Risk Screening

- **Model all point, area, and mobile sources in state**
- **Universal receptor grid with ~100 m resolution (whole state)**
- **~100 air toxics (RAPIDS) + criteria**
- **Estimate total concentrations, inhalation risks, non-inhalation risks (individual and population)**

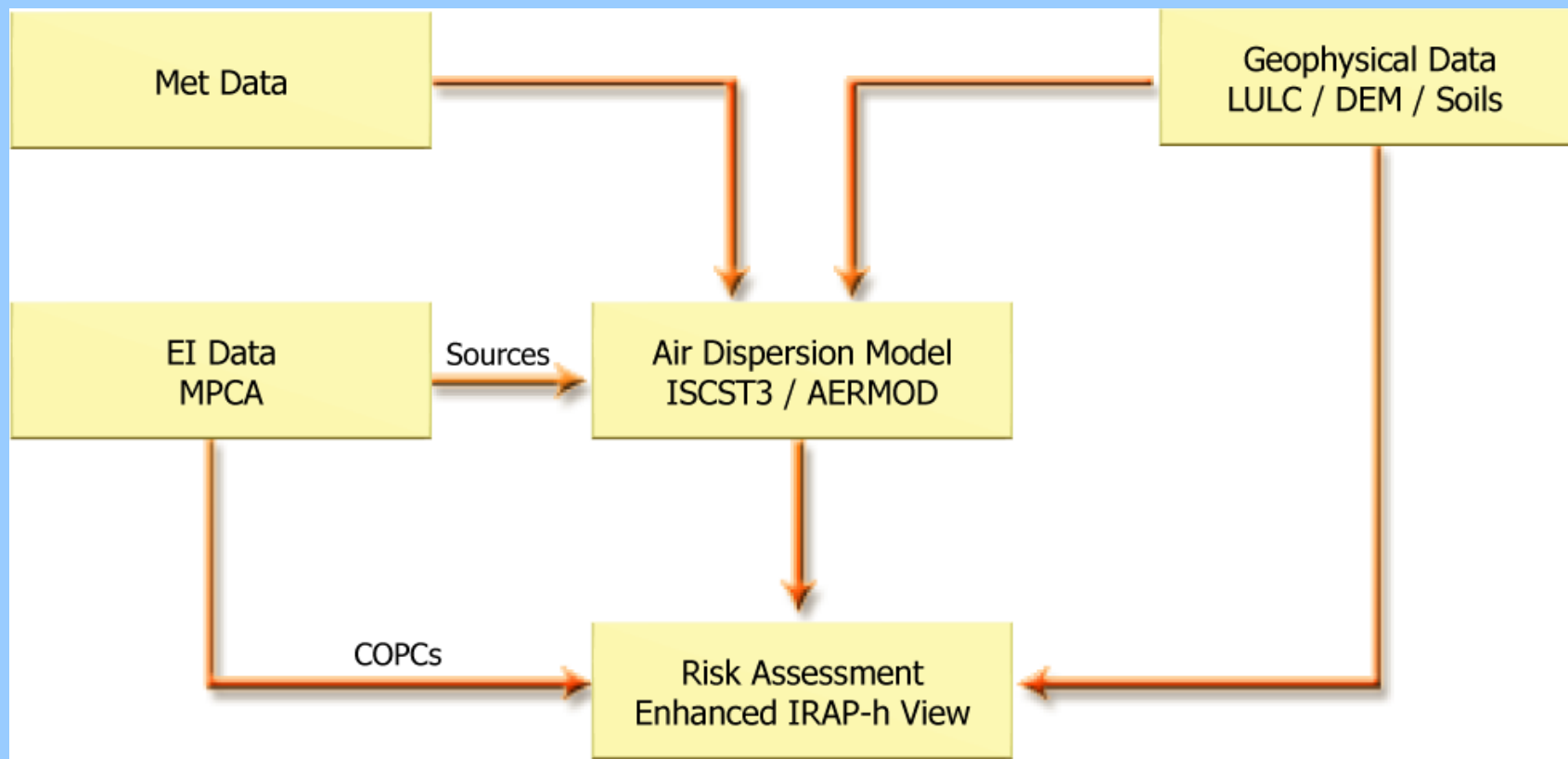


# Statewide Cumulative Risk Screening

- **Use results to prioritize chemicals, source categories, sectors, facilities, high risk locations for further work**
- **Database will allow testing of policy choices**
- **Work with stakeholders to develop plans to reduce risks**

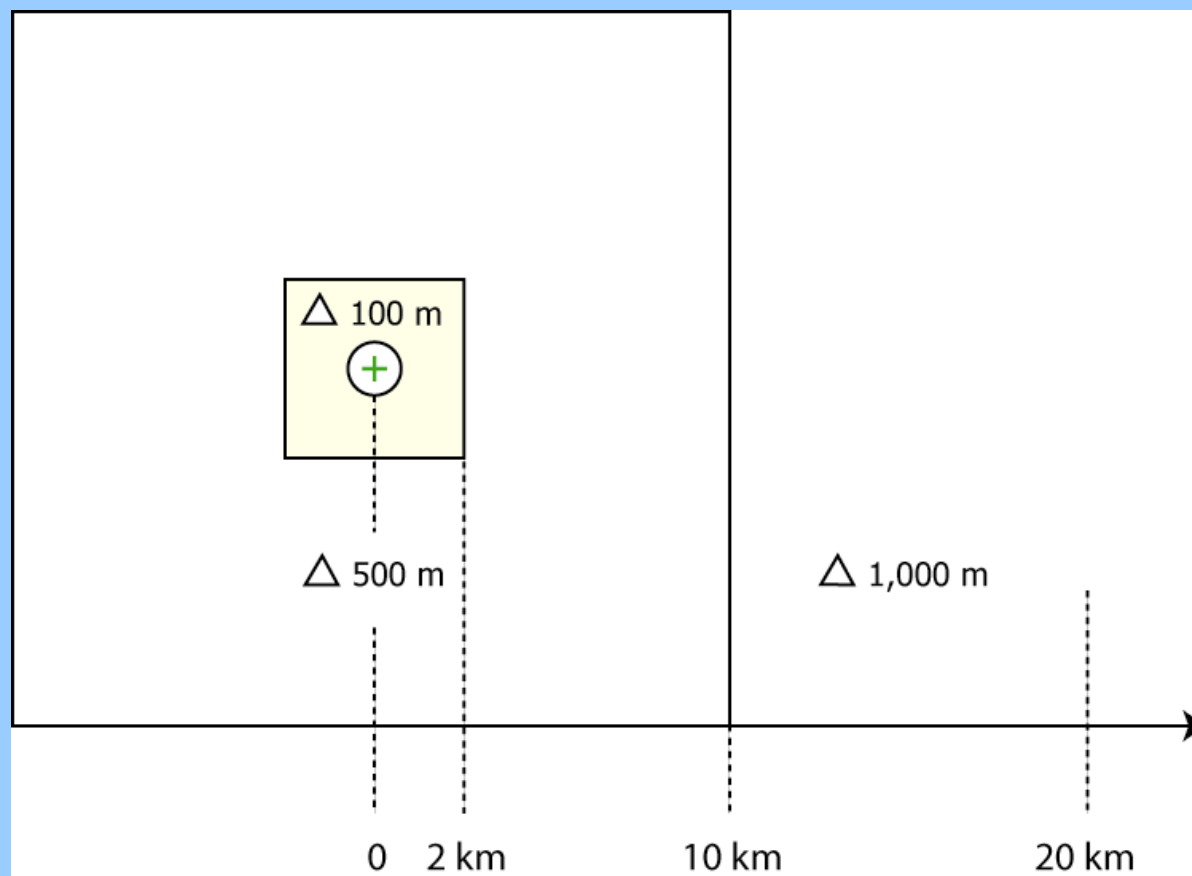


# System Architecture



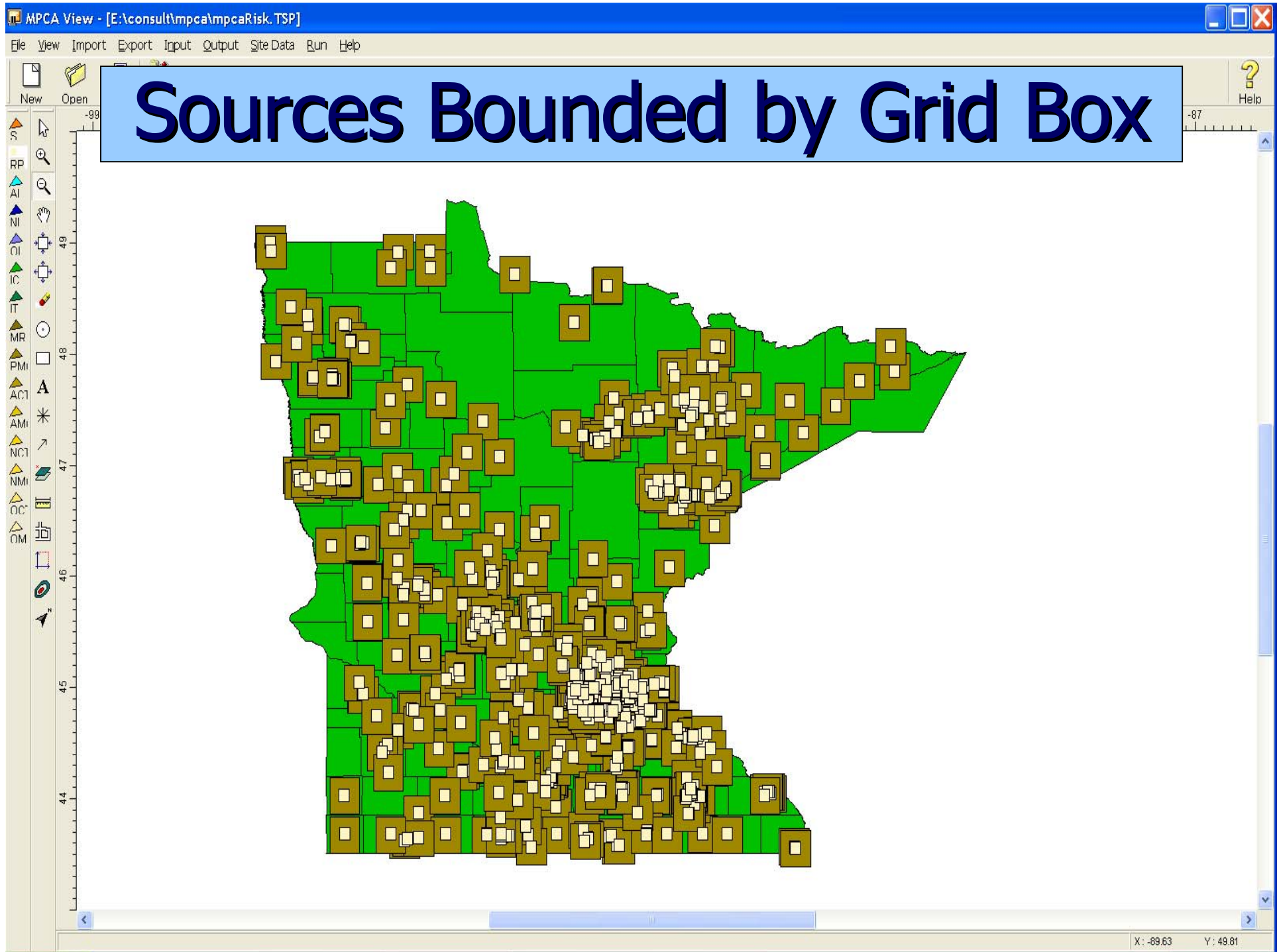
# Grid Node Definition

## ■ Point Source



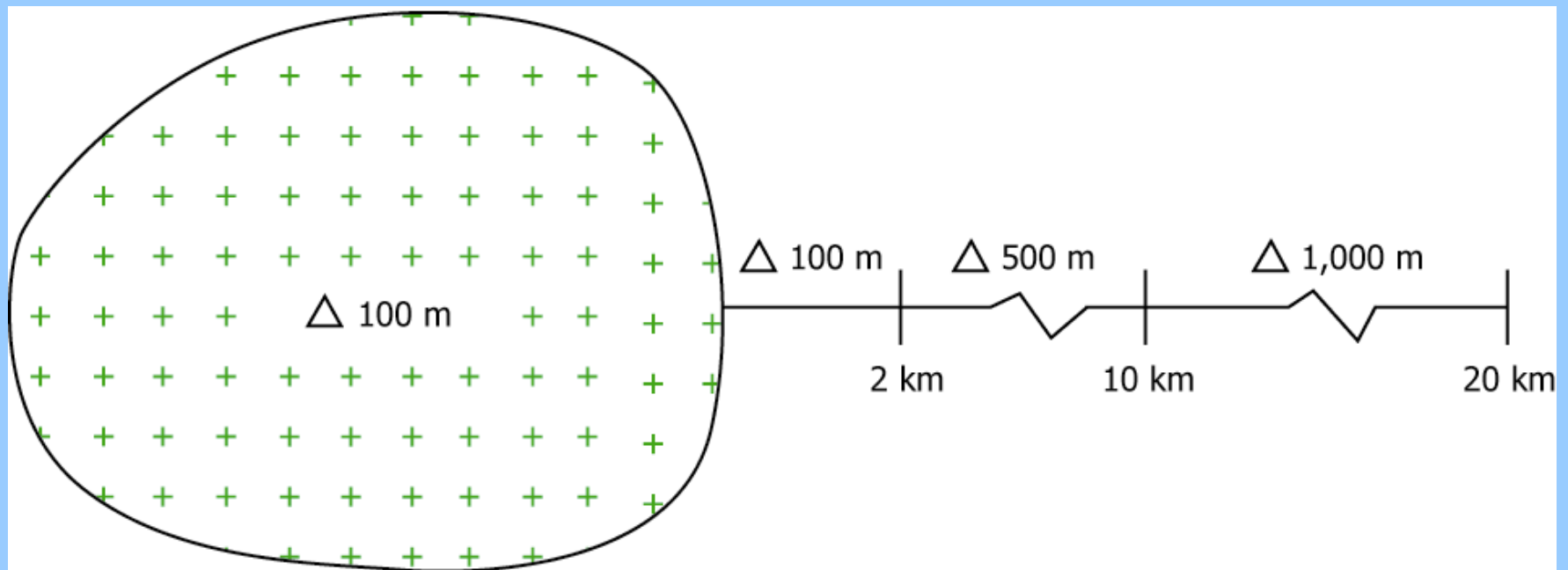
Statewide Cumulative Risk Screening





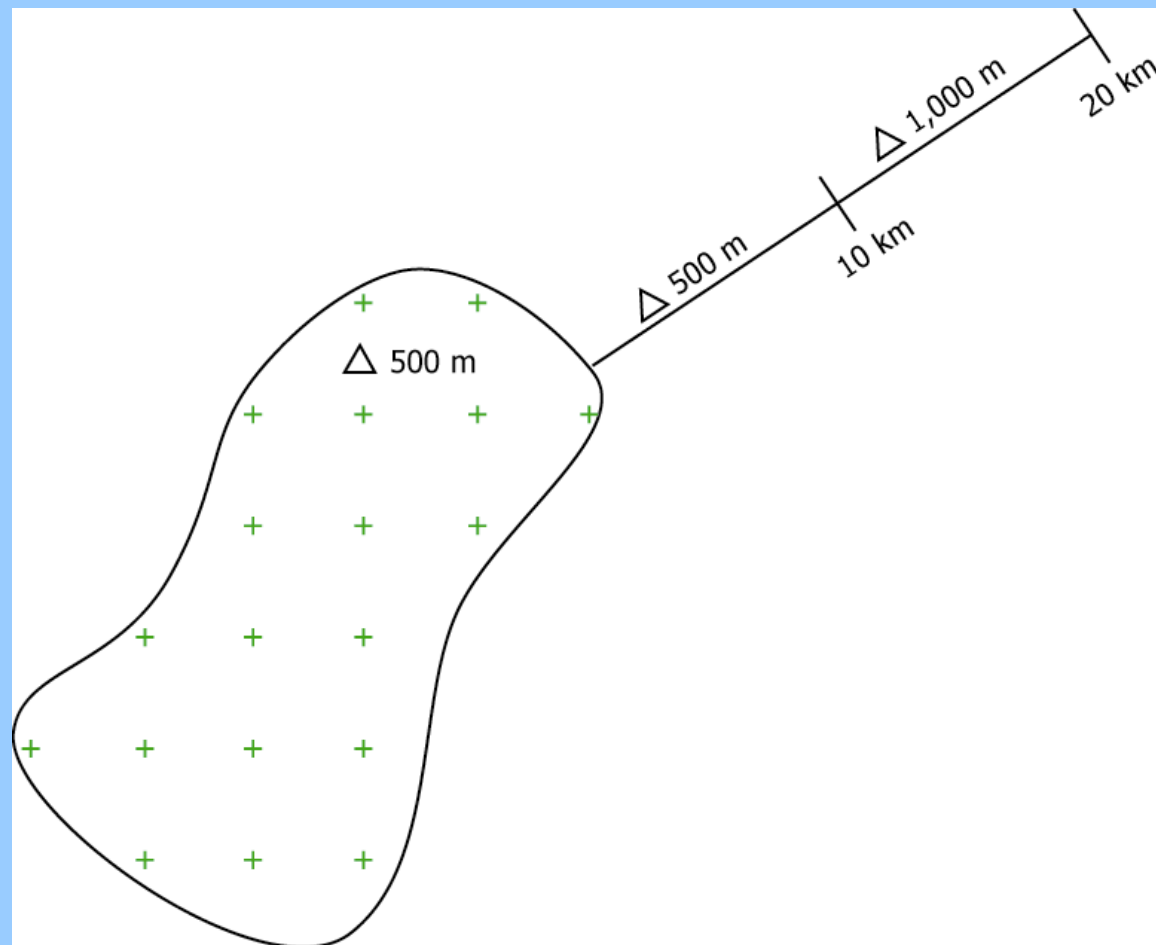
# Grid Node Definition

## ■ Minor Area Source



# Grid Node Definition

## ■ Major Area Source





# Statewide ADM Runs

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- ✓ 8800 Point Sources

- Vapor - 34 Gbytes
  - Particle - 36 Gbytes

- 1400 Area Sources

- Risk Runs (Expected) > 120 Gbytes



# Issues

- **Limitations of IRAP/HHRAP as tools for multimedia air toxics assessments**
  - Long-range transport / revolatilization (subsequent movement in environment)
  - Bioaccumulation-related issues
- **What can we do about mobile sources and other high risks?**



# **The Twin Cities VOC/PM<sub>2.5</sub> Personal Exposure Study**

**Funding Sources: EPA STAR Grants  
GR825241-01-0 and R827928-010**

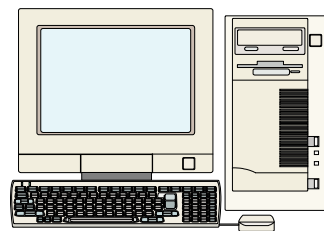
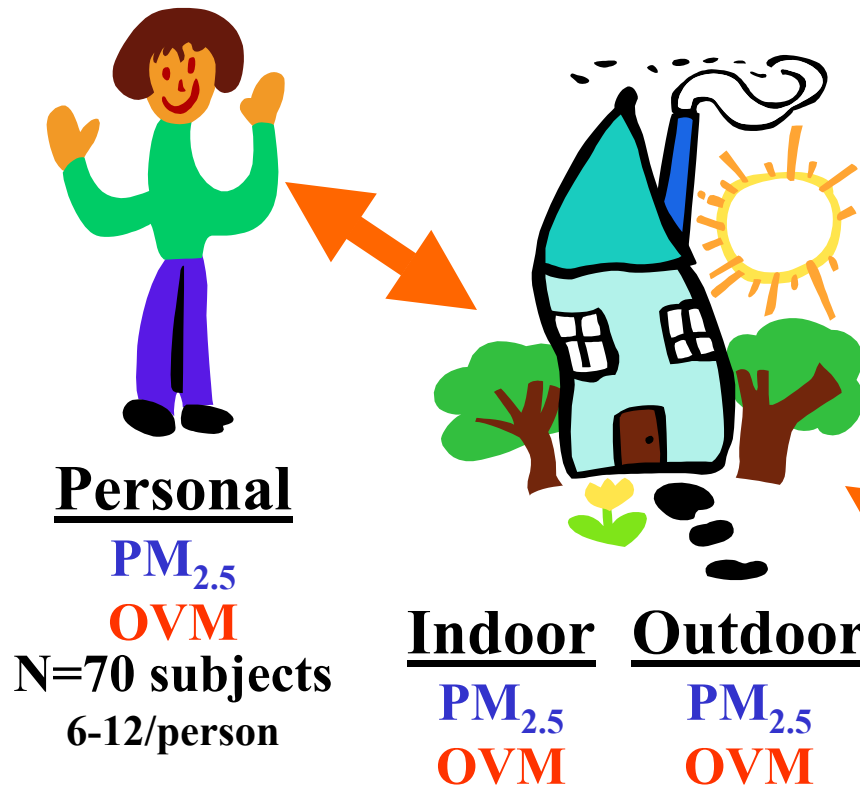
**Gregory C. Pratt, Don Bock, Chun Yi Wu**  
Minnesota Pollution Control Agency, St. Paul

**Ken Sexton, John Adgate**  
University of Minnesota, Minneapolis

**Thomas Stock, Maria Morandi**  
University of Texas, Houston

**PM<sub>2.5</sub>: 116 24-hour periods**

**VOCs: 58 48-hour periods**



**Modeling**  
**VOCs**

**Neighborhood**

**PM<sub>2.5</sub> (FRM)**

**OVM**

**VOC Canister**

**N=3**

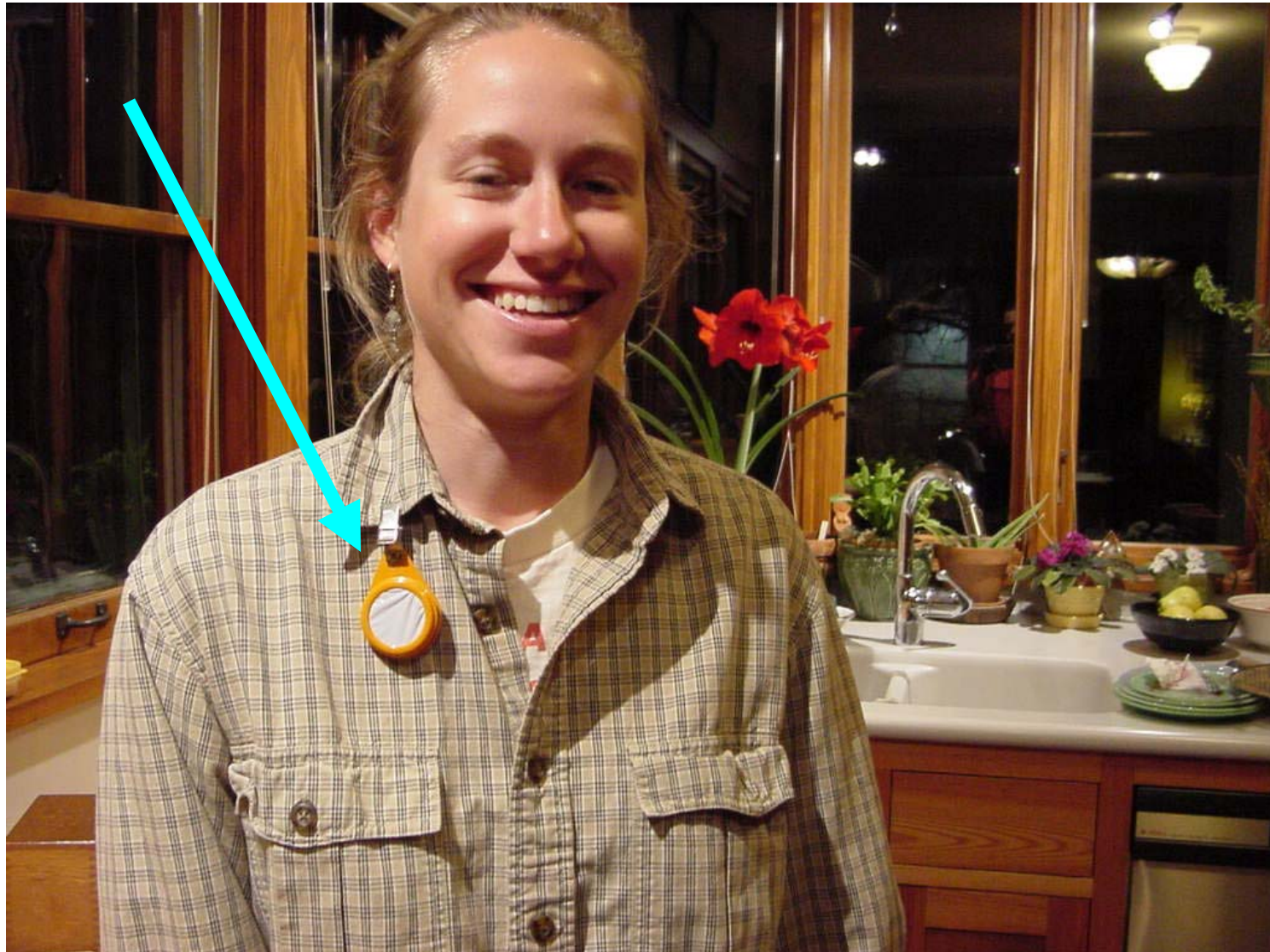
**Central Site**

**PM<sub>2.5</sub> (FRM)**

**VOC Canister**

**N=2**

## 3M Personal Organic Vapor Monitor (OVM)



## Air Dispersion Modeling of VOCs

- **Model = ISCST3 version 01001 (EPA regulatory model)**
- **Met data = 1999 MSP airport**
- **Modeled times = 58 48-hour periods corresponding to measurement periods**
- **Receptors = community monitoring sites (OVMS and canisters) and outside participant homes (OVMS)**

# Sources

- **Point Sources** - large stationary sources inventoried individually (424 in metro)
- **Mobile Sources** - cars, trucks, planes, trains, boats, construction equipment, farm equipment, off-road vehicles, lawn and garden equipment, etc. (apportioned to census tracts)
- **Area Sources** - smaller stationary sources inventoried collectively (22 categories apportioned to census tracts)

# Point Sources

- **Emissions of 82 pollutants using RAPIDS**
- **Company review of emission estimates**
- **Source locations by GIS address-matching + GPS**
- **Stack parameters averaged over all sources at a facility from (by priority):**
  - 1 DELTA (state permitting system)**
  - 2 Default OTAG values by SCC code**
  - 3 Average OTAG values**



## **Mobile Sources - On-Road and Non-Road**

- **Miles of each road category in each census tract calculated using GIS**
- **MnDOT traffic count data obtained (counts by county and road category)**
- **Used GIS to calculate VMT in census tract**
- **Emission Factors (per VMT) from RAPIDS (based on Mobile 5 model)**
- **Emissions assigned to census tract and modeled as an area source**

## **Mobile Sources - Rail and Air**

- **RAPIDS rail emission were apportioned to census tracts based on the length of rail line in the tract**
- **Airport-related emissions from each airport in RAPIDS were apportioned to the census tract containing the airport**

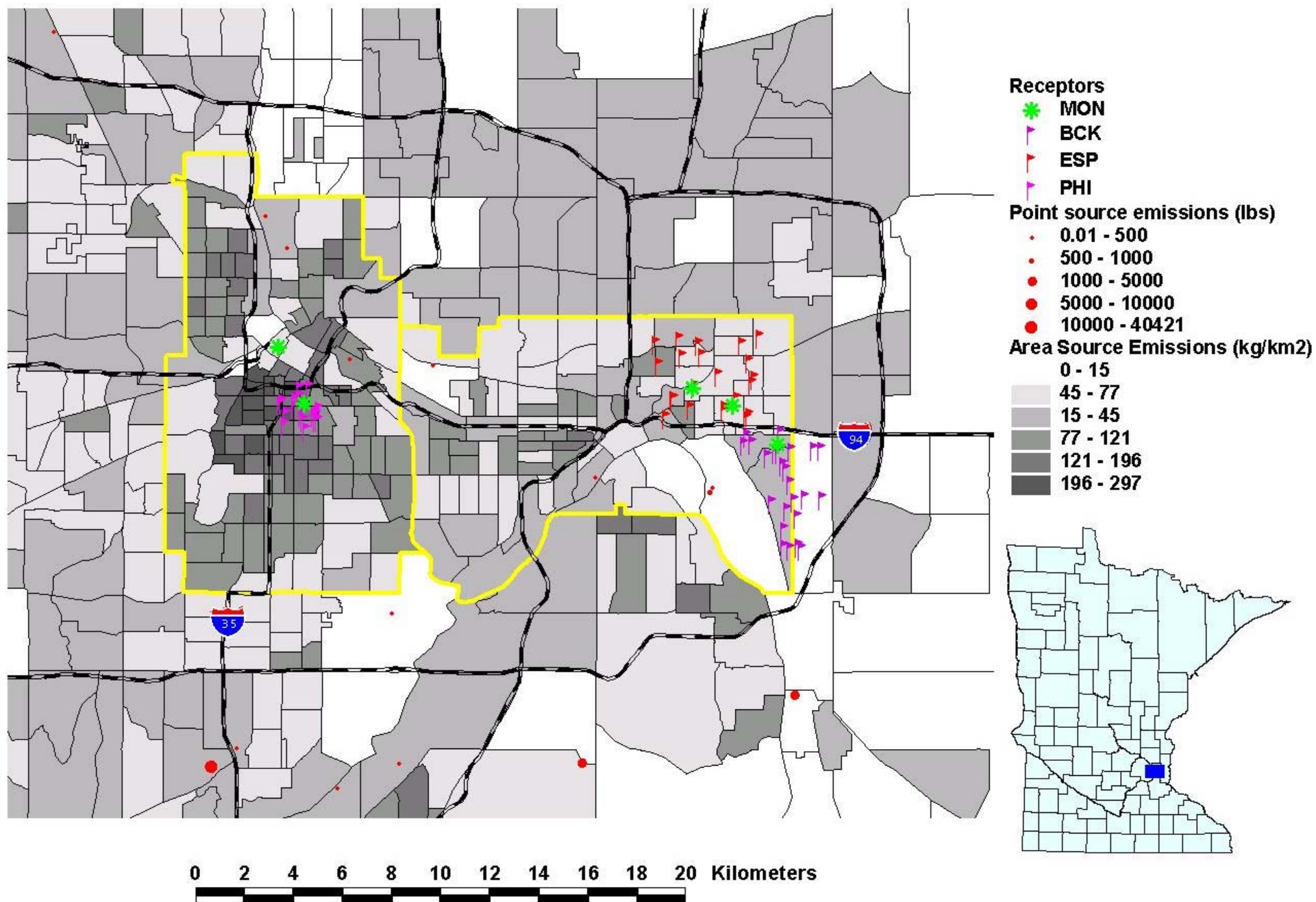
# Area Source Categories - 1

<b>Agricultural Pesticide Application</b>	<b>Not Done (no VOCs from study)</b>
<b>Architectural Surface Coatings</b>	<b>Population parsing</b>
<b>Asphalt Paving</b>	<b>Not Done (no VOCs from study)</b>
<b>Auto Body Refinishing</b>	<b>Population parsing</b>
<b>Chromium Electroplating</b>	<b>Not Done (no VOCs from study)</b>
<b>Consumer and Commercial Solvent Use</b>	<b>Population parsing</b>
<b>Dry Cleaning</b>	<b>Population parsing</b>
<b>Gasoline Marketing</b>	<b>Population parsing</b>
<b>Graphic Arts</b>	<b>Population parsing</b>
<b>Hospital Sterilizers</b>	<b>Population parsing</b>
<b>Human Cremation</b>	<b>Not Done (no VOCs from study)</b>

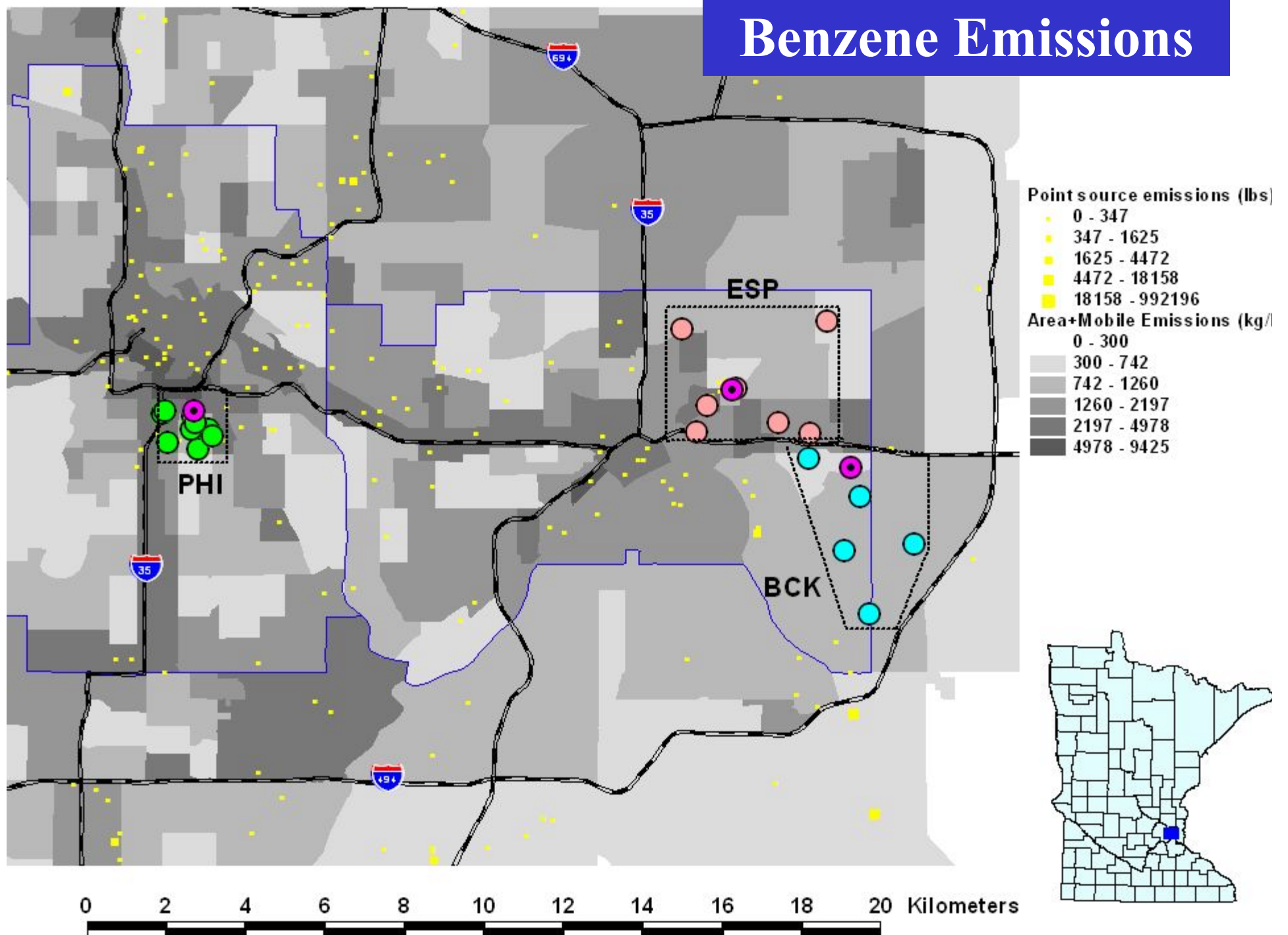
## Area Source Categories - 2

<b>Industrial Surface Coating</b>	<b>Population parsing</b>
<b>Landfills</b>	<b>Assign to Census Tract</b>
<b>Marine Vessel Loading etc.</b>	<b>Not Done (only Duluth)</b>
<b>Prescribed Burning</b>	<b>Not Done (data not available)</b>
<b>Public Owned Treatment Works</b>	<b>Done as Point Sources</b>
<b>Residential Fuel Combustion</b>	<b>Population parsing</b>
<b>Residential Wood Combustion</b>	<b>Population parsing</b>
<b>Solvent Cleaning</b>	<b>Population parsing</b>
<b>Structure Fires</b>	<b>Population parsing</b>
<b>Traffic Markings</b>	<b>Lane Miles</b>
<b>Wild Fires</b>	<b>Area</b>

# Tetrachloroethylene Emissions

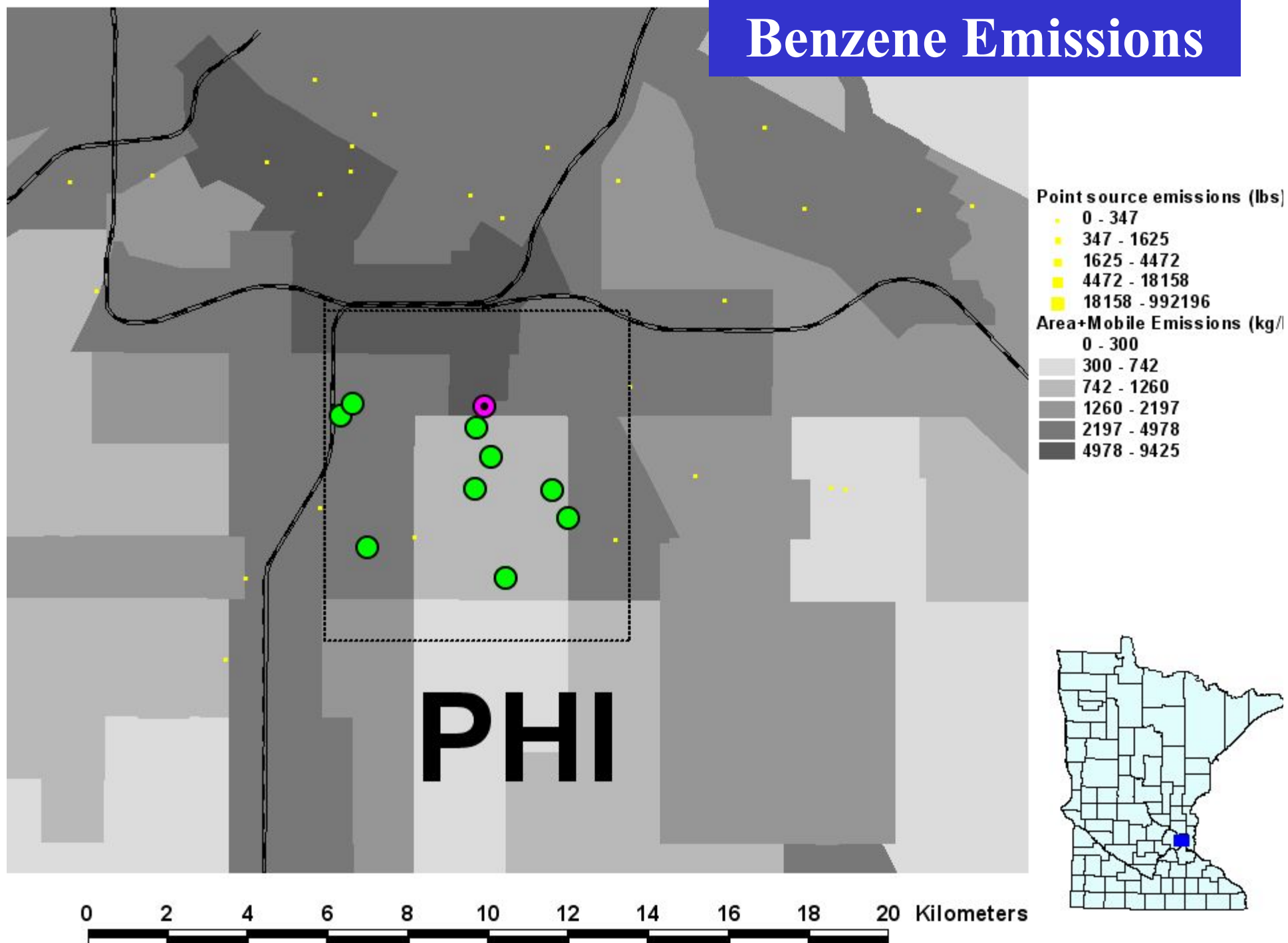


# Benzene Emissions





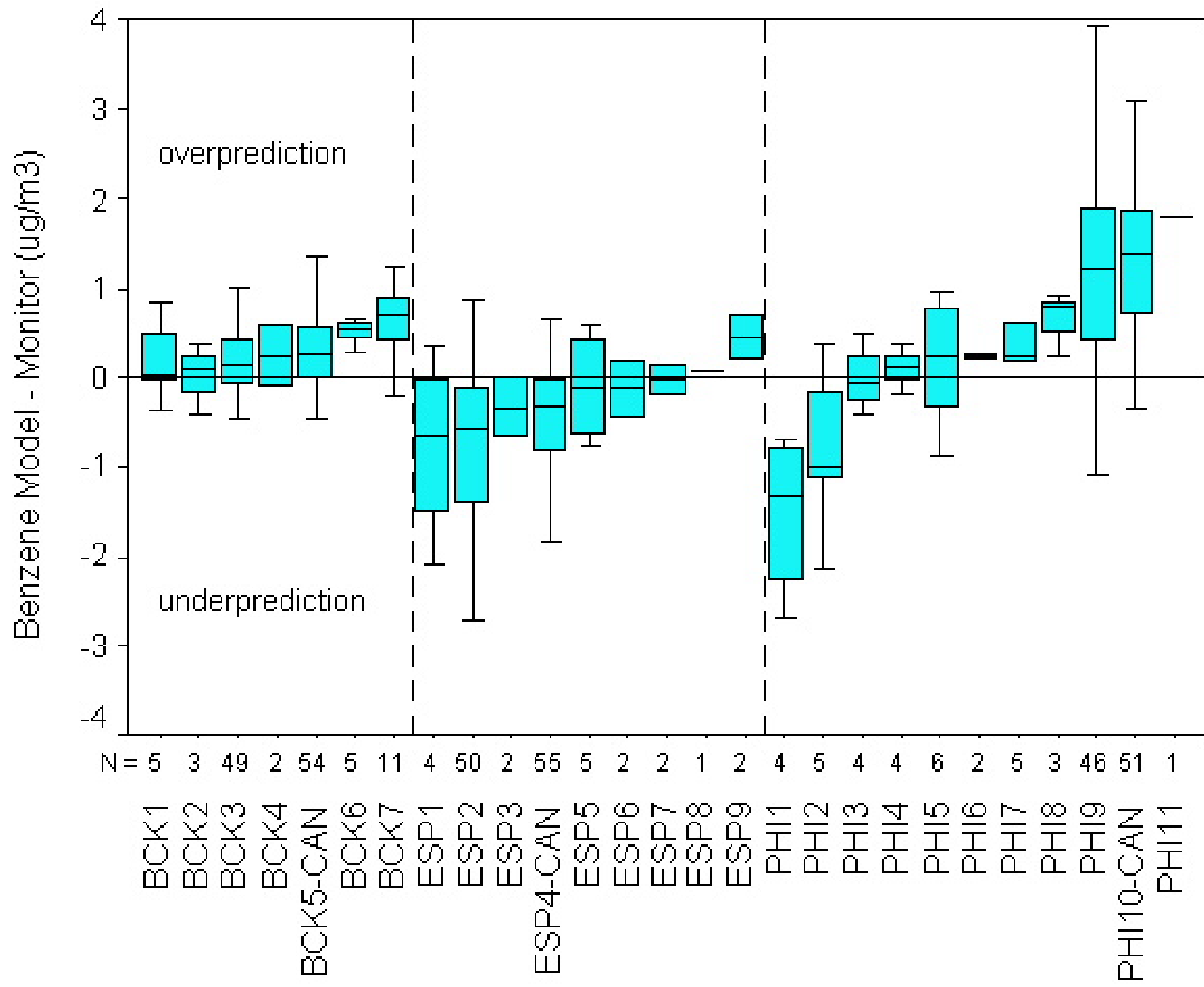
# Benzene Emissions

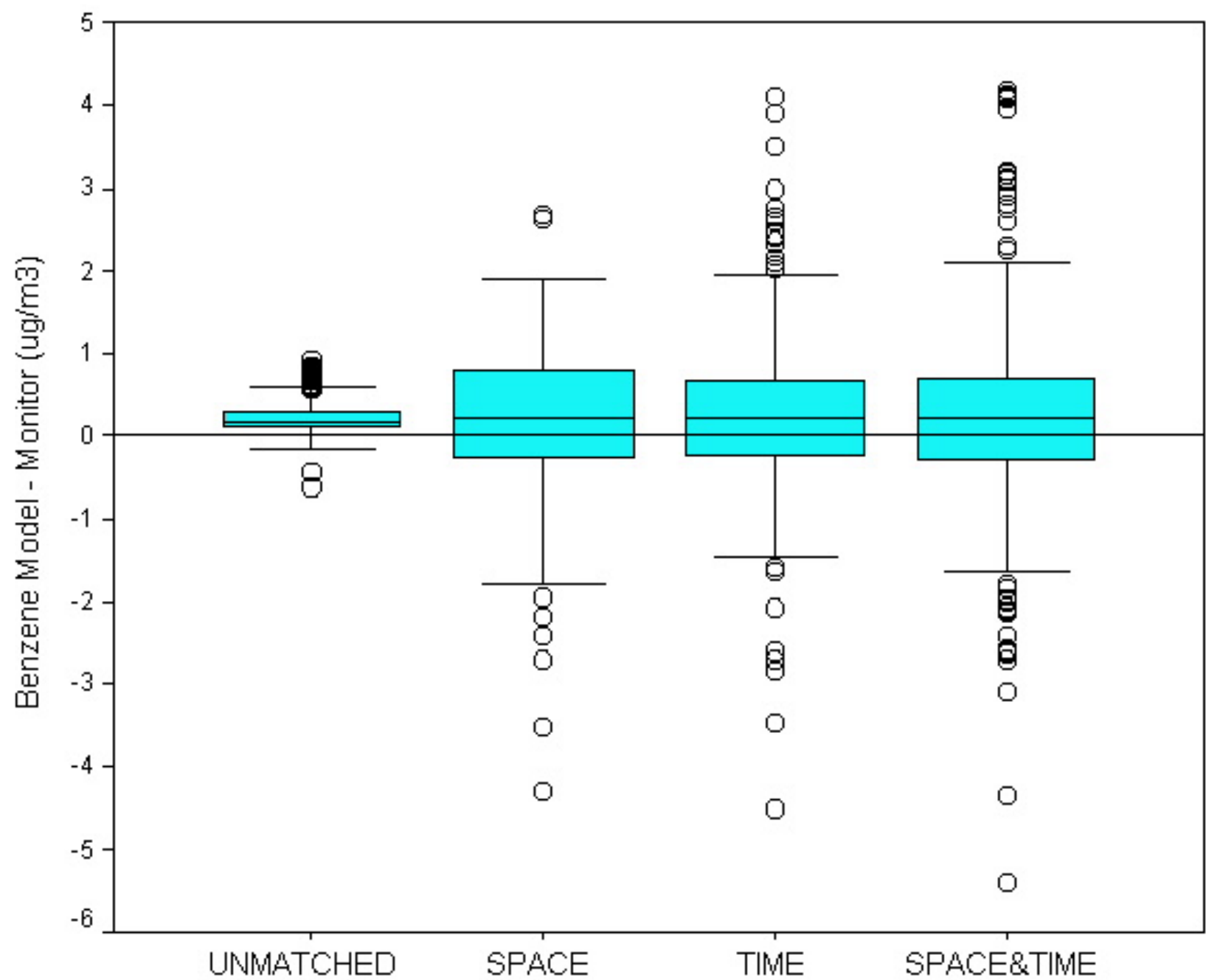


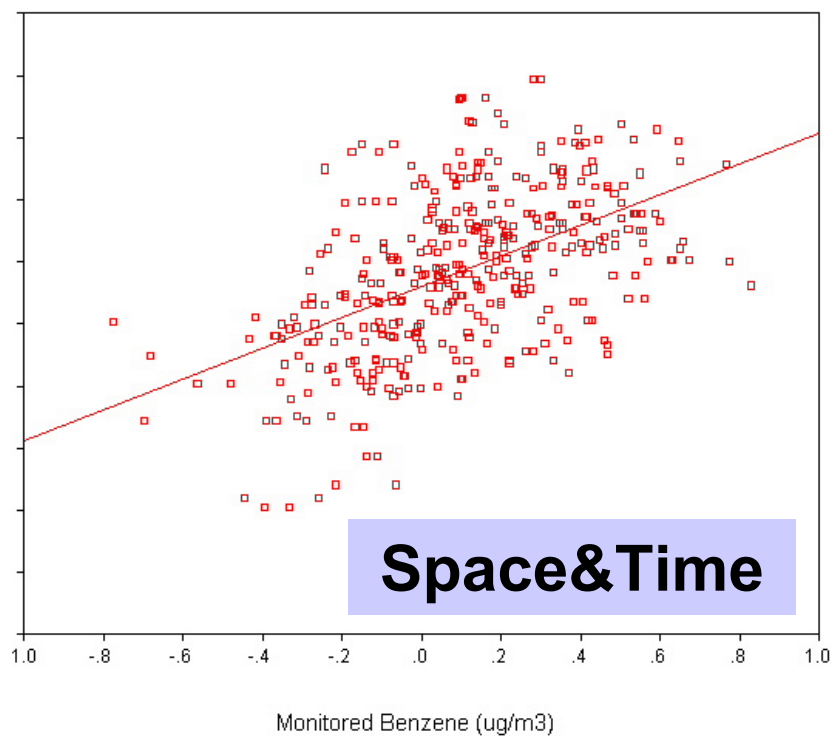
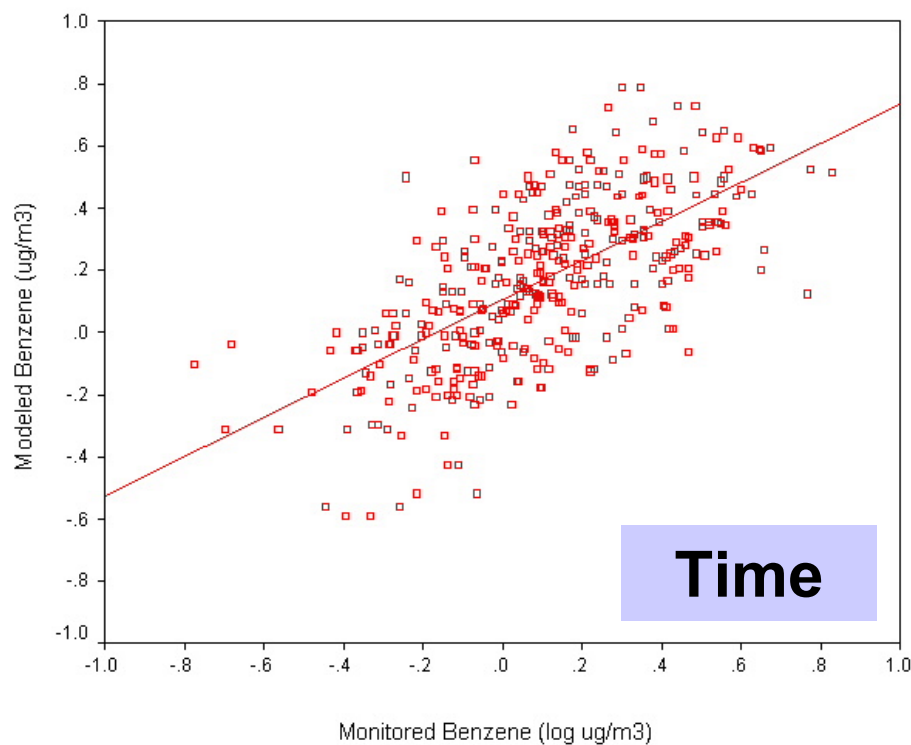
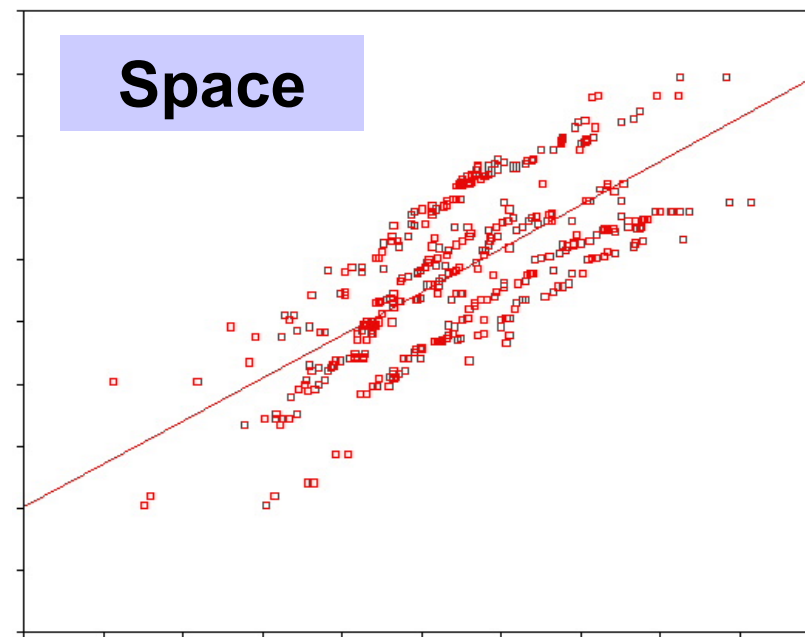
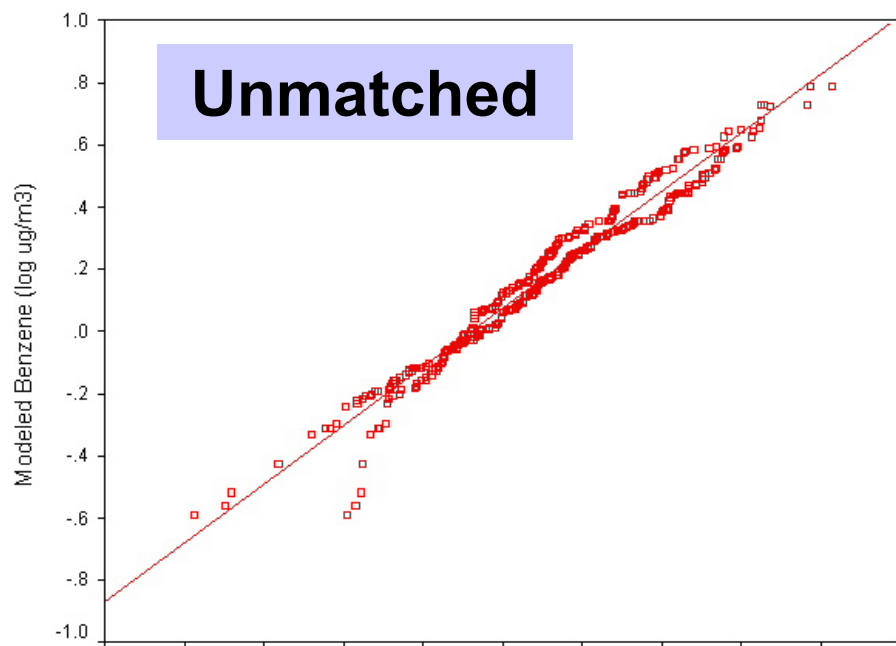
Pollutant	Source Category	Emissions (%)	Modeled Concentrations (%)		
			BCK	ESP	PHI
Benzene	Point	1	1	0	0
	Area	26	12	13	9
	Mobile	73	87	86	91
Chloroform	Point	26	6	6	4
	Area	74	94	94	96
	Mobile	0	0	0	0
Ethylbenzene	Point	5	4	4	6
	Area	10	4	5	2
	Mobile	85	92	91	92
Dichloromethane	Point	21	38	39	39
	Area	79	62	61	61
	Mobile	0	0	0	0
Styrene	Point	55	10	10	9
	Area	1	1	1	0

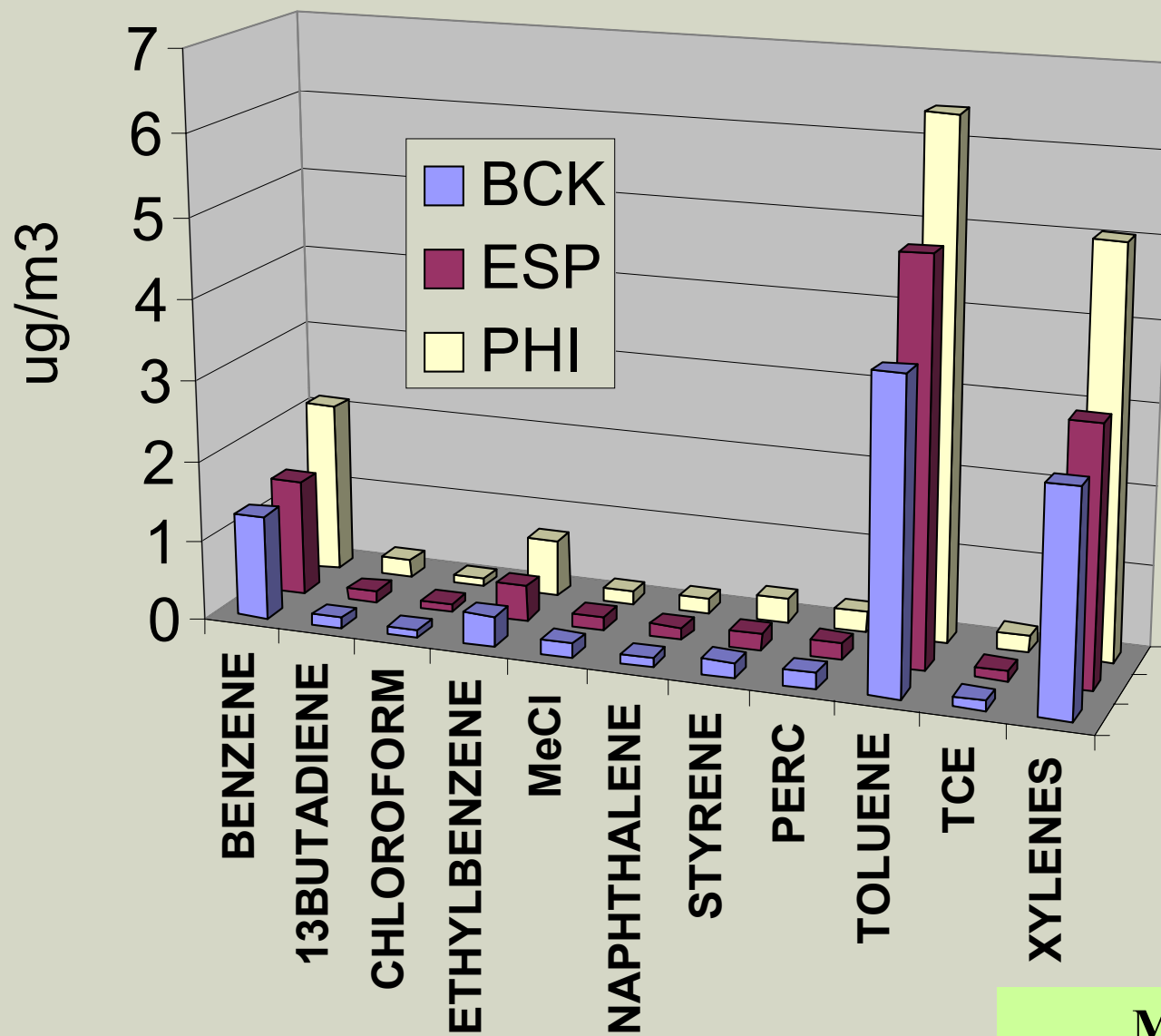


Pollutant	Source Category	Emissions (%)	Modeled Concentrations (%)		
			BCK	ESP	PHI
Tetra chloro ethylene	Point	14	5	3	3
	Area	86	95	97	97
	Mobile	0	0	0	0
Toluene	Point	5	5	16	2
	Area	37	39	37	41
	Mobile	58	55	46	57
Trichloroethylene	Point	66	56	71	90
	Area	34	44	29	10
	Mobile	0	0	0	0
Xylenes	Point	7	6	5	5
	Area	34	40	44	44
	Mobile	59	54	51	51

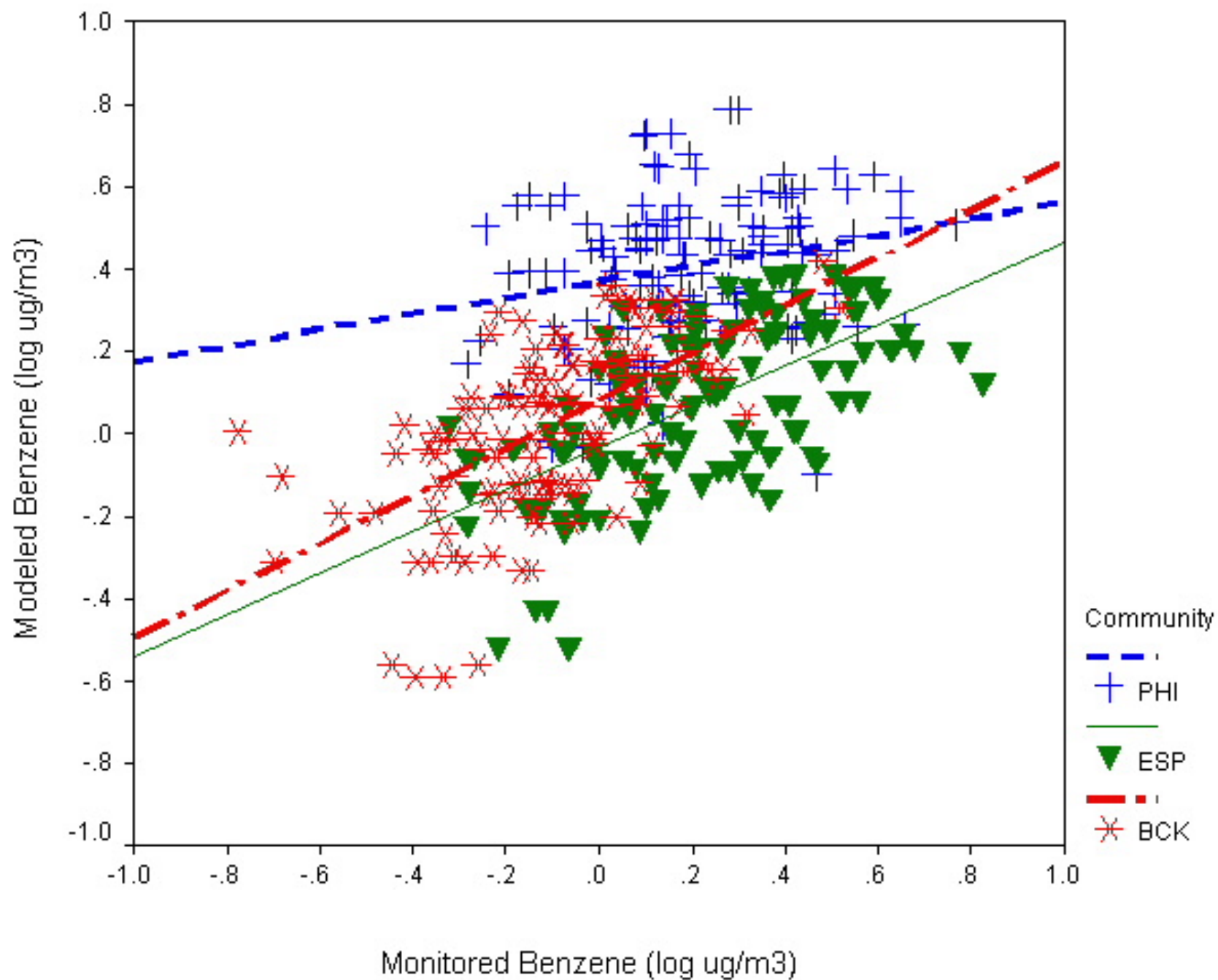


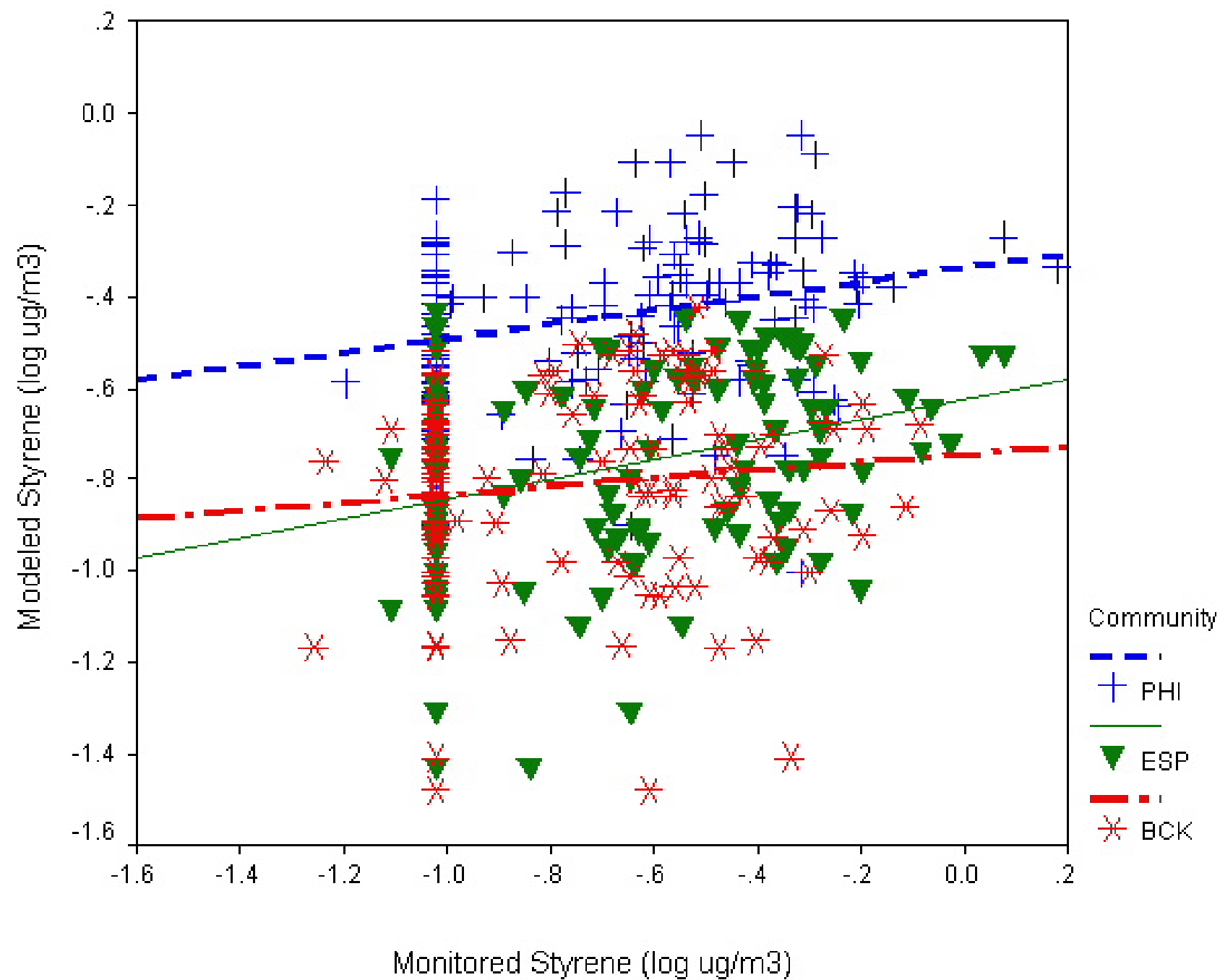






**Modeled  
Concentrations**





## Regressions between modeled and monitored concentrations

Pollutant	Canis ters			Outdoor OVMs			Indoor OVMs			Personal OVMs		
	BCK	ESP	PHI	BCK	ESP	PHI	BCK	ESP	PHI	BCK	ESP	PHI
Benzene	0.38	0.43	0.16	0.44	0.37	0.08	0.04	0.09	-0.01	0.06	0.05	-0.01
Carbon Tetrachloride	-0.02	-0.01	-0.01	0.01	-0.01	-0.01	0.00	-0.01	0.01	-0.01	0.00	-0.01
Chloroform	-0.03	0.02	0.36	-0.03	-0.01	-0.02	-0.01	-0.01	0.00	0.03	-0.01	-0.01
Ethylbenzene	0.32	0.40	0.17	0.42	0.32	0.04	0.01	0.03	-0.01	0.08	0.02	-0.01
Methylene Chloride	-0.02	0.03	0.19	-0.01	-0.02	0.04	0.01	-0.01	0.02	-0.01	-0.01	0.00
Styrene	-0.02	0.13	0.12	0.01	0.12	-0.02	0.04	-0.01	-0.01	0.03	0.00	-0.01
Tetrachloroethylene	n/a	n/a	n/a	-0.01	0.14	0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Toluene	0.50	0.46	0.19	-0.02	0.08	-0.01	0.00	0.00	-0.01	0.07	-0.01	0.02
Trichloroethylene	-0.02	-0.02	0.00	0.08	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00
Xylenes	0.36	0.39	0.19	0.51	0.34	0.09	0.01	0.05	-0.01	0.07	0.02	-0.01
		p less than or equal to 0.05 and R2 > 0.1										
		p less than or equal to 0.001 and R2 > 0.2										



# Conclusions

- **Generally for measured PM<sub>2.5</sub> & VOCs:**  
**Personal > Indoor > Outdoor**
- **High cross-sectional and longitudinal variability**
- **Outdoor not a good predictor of personal — indoor better, but not great >> implies microenvironments are important**
- **OVMs compared well with canisters for most VOCs in this study – poorly for some VOCs**

# Conclusions

- **ISCST model predictions (matched in time and space) within factor of 2 on average for most VOCs (better unmatched)**
- **Model performed better for mobile source pollutants with higher concentrations**
- **ISCST performed best in BCK (lowest emissions) and poorest in PHI (highest emissions)**
- **Model performed best unmatched in time and space**